

# **Clock Jitter Limiting Scheme in Video Transmission through Multiple Stages**

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## **RELATED APPLICATION**

This application claims the benefit of co-pending U.S. Provisional Application Ser. No. 60/271,331, filed February 23, 2001, entitled "Clock Jitter Limiting Scheme Using Digital Scaling."

## **BACKGROUND OF THE INVENTION**

### Technical Field

This invention relates to data communications. More specifically, the invention relates to digital scaling to limit clock jitter in video transmission through multiple stages.

### Description of the Related Art

Some display applications require transmission of video content through multiple stages in a daisy chain, each with a switch allowing that stage's video stream to be selected between the video stream from the preceding stage and the video stream from another source at each stage. As the video stream proceeds from one stage to the next across multiple links, the jitter content in the clocking accumulates. This jitter creates an inherent limitation to the number of links that can be timed without correction. When the jitter exceeds the specification for the link technology, the video data is corrupted.

This process is complicated by the fact that the video stream may be

transmitted at any of a variety of frequencies. Although the downstream stages could re-clock the video if it were always sent at the same frequency, it is problematic for these downstream stages to anticipate the changeable video frequency and to create the necessary low-jitter clock in programmable logic.

FIG. 1 shows a conventional method of daisy-chaining digital video signals through multiple stages, each having its own host system. On each host system such as a system 10, a signal containing digital video from the preceding system enters through a receiver chip ('RX') 11. The host selects either its own video stream (from the 'VGA' chip) 12 or passes through the stream from the preceding stage, using a multiplexer ('MUX') 13. The multiplexer switches the data signals, the control signals, and the clock into the transmitter ('TX') 14, which outputs through a connection to the next host system of RX 15, VGA 16, MUX 17 and TX 18.

Since jitter accumulates on a clock signal whenever it passes through additional circuitry, the jitter arriving through the 'RX' device is aggravated by the multiplexer and transmitter circuitry as it passes to the next host stage.

FIG. 2 shows a conventional method of reducing the jitter accumulation by creating a new clock at each stage of the video switching. In a host system such as a system 20, either the digital video from the preceding host system entering through a receiver chip ('RX') 21 or the digital video from own video stream (from the 'VGA' chip) 22 is selected using a multiplexer 23. The selected video is gated with a new clock ('OSC') 24 before being transmitted using a transmitter ('TX') 25, which outputs through a connection to the next host system of RX 26, VGA 27, MUX 28, OSC 29 and TX 30.

If the jitter characteristic of the new clock is better than the received clock,

then the accumulation will be slower. If the new clock has extremely small jitter (such as from a crystal source), then the jitter accumulation will be so small as to allow a number of stages to be connected in series.

However, there are still problems in such schemes. The phase of the new clock must be matched to the phase of the data and control signals arriving through the receiver, to guarantee proper setup and hold margins at each transmitter input. Adjusting the phase is difficult for a design handling multiple video frequencies. A system with multiple possible video frequencies will also require a re-programmable clock that always maintains very small jitter. Each stage of the chain must know the required frequency for data received by it from earlier stages. This is a problem for general-purpose systems where multiple video frequencies are used.

Therefore, there is a need for a new scheme to reduce clock jitter during video transmission across multiple stages without the necessity of adding a re-programmable clock source at each stage.

## **SUMMARY OF THE INVENTION**

It is an object of the present invention to limit clock jitter as video content is transmitted in multiple stages.

The foregoing and other objects are accomplished by providing at each stage a digital video scaler (DVS) for producing a constant resolution display from the incoming video data before re-clocking the video data so that a clock source of a constant frequency may be used for re-clocking.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a schematic block diagram of a conventional method for chaining video signals through multiple stages.

Figure 2 is a schematic block diagram of a conventional method for reducing jitter by adding a new clock source at each stage.

Figure 3 is a schematic block diagram of the present invention for reducing jitter using a digital video scaler (DVS).

Figure 4 is a schematic block diagram of the DVS.

Figure 5 is a schematic block diagram of an alternative embodiment of the present invention.

## **DETAILED DESCRIPTION OF THE INVENTION**

FIG. 3 shows a system of the present invention for limiting clock jitter based on the methodology of daisy-chaining multiple systems together using a digital scaling solution. The system 40 includes a receiver ('RX') 41 for receiving video signals from the preceding system, a digital video scaler ('DVS') 42, a multiplexer ('MUX') 45, and a transmitter ('TX') 46.

The RX 41 accepts high-speed signals containing digital video using an interface technology, such as Transition Minimized Differential Signaling (TMDS) or Low-Voltage Differential Signaling (LVDS). For more details on TMDS, refer to DVI Specification Revision 1.0, April 2, 1999 from Digital Display Working Group (DDWG).

These signals may arrive at a variety of frequencies according to the mode of display used. The display mode includes a resolution (for example, 1024 rows by 768 columns) as well as a refresh rate and blanking times. These parameters combined

define a unique clock rate. The digital video data received by the RX 41 is processed by the DVS 42, which scales the received digital video data to a constant resolution using a constant-frequency clock ('OSC') 43. The DVS 42 may be part of a digital visual controller (DVC). The MUX 45 selects either its own video stream (from the 'VGA' chip) 44 or the scaled video stream from the DVS to send it to the next host system using a transmitter ('TX') 46, which outputs through a connection to the next system 47 having RX 48, DVS 49, MUX 52 and TX 53.

FIG. 4 further shows a detailed block diagram of the DVS 42, which includes a retiming first-in-first-out queue ('FIFO') 61, a scaling engine 62, and an output driver 63. The digital video data received by the RX 41 of FIG. 3 enters the retiming FIFO 61 so that the data is written into the FIFO 61 using the frequency defined by the display mode. The data is extracted from the retiming FIFO 61 using the constant-frequency oscillator clock ('OSC') 43. Since this frequency is constant, all ports downstream from this point will respond to the same frequency of information, with no need to perform additional scaling. The data drawn from the FIFO is processed by the scaling engine 62, which creates additional pixel points by interpolation ('scaling') algorithms, which are well known to those skilled in the art. All required display modes are scaled to a constant output timing by this block. The scaled information is driven through the output driver 63, from which it emerges again as a digital data stream. This digital data stream is transmitted to the next receiver block in the daisy chain by using the TX 46 of FIG. 3.

The present invention differs from the conventional method in FIG. 2 in that the present invention may use a constant-frequency oscillator for the new clock. Since the output of the DVS is always a video stream of the same resolution, each stage of the

chain does not need to know the frequency of its incoming video stream.

FIG. 5 shows an alternative implementation of the present invention. The system 70 is different from the system in FIG. 3 in that the received digital video data by a RX 71 is multiplexed with its own data stream (from VGA 74) before being scaled by a DVS 72 and transmitted by a TX 76 to the next system 77.

The video stream emerging from the DVS such as 42, 49, 72 and 79 is designed to be of a constant resolution according to the capabilities of the overall system. It may be selected as the native resolution of the intended display device, or simply a resolution compatible (through up-scaling or down-scaling) with all of the possible resolutions driven by the host systems' VGA controllers.

There are numerous benefits using the present invention. Since the present invention uses a constant-frequency oscillator, the oscillator can be designed to have minimal jitter. Since the oscillator need not be re-programmable, it can be designed to drive the multiplexer and the transmitter to meet their specifications, regardless of the phase and frequency of the original video data and clock.

The requirements of the display device are also simplified, as it will always be driven by the same video resolution and frequency. There is no need for a multiple-resolution display, such as a CRT or a scaling flat panel monitor.

Since the DVS may be part of a digital visual controller (DVC), other features of the DVC logic may also be incorporated into this solution, such as eliminating the separate multiplexer, and superimposing an on-screen display (OSD) message on the video stream according to which DVC is performing the scaling from the original video content.

By using the present invention, the signals at each stage are not limited to using

the same interface technology. Since digital scaling is done at each stage, one stage using TMDS, for example, may be followed by another stage using LVDS.

While the invention has been described with reference to preferred embodiments, it is not intended to be limited to those embodiments. It will be appreciated by those of ordinary skilled in the art that many modifications can be made to the structure and form of the described embodiments without departing from the spirit and scope of this invention.